GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Cross-sectional Epidemiological Survey of Leptospirosis Risk Factors in Cattle Farms in the Morobe Province of Papua New Guinea

By

Sinafa Robby[1,2], Kari Sogera Iamba[2], Stephanie Tringin[2], and Macquin Maino[1]

[1]School of Agriculture Papua New Guinea University of Technology, Private Mail Bag, 411 Lae City, Morobe Province, Papua New Guinea.

[2]Papua New Guinea University of Natural Resources and Environment, Private Mail Bag, 613 Kokopo City, East New Britain Province, Papua New Guinea.

Article History

Received: 11/07/2025
Accepted: 19/07/2025
Published: 22/07/2025

Vol – 2 Issue –7

PP: -53-61

Abstract

Leptospirosis represents a critical zoonotic bacterial disease affecting cattle productivity in tropical regions, yet limited epidemiological data exists for Papua New Guinea (PNG). This cross-sectional survey was conducted from June to August 2023 to assess risk factors associated with potential leptospirosis transmission and evaluate farmers' knowledge and management practices in cattle farms across Morobe Province, PNG. Data were collected from 22 cattle farms (4 commercials, 18 smallholder) through structured questionnaires and interviews covering farm characteristics, environmental risk factors, farmers' knowledge, clinical observations, and management practices. Among 22 farms surveyed (response rate 100%), 82% of farmers lacked knowledge about leptospirosis. High-risk environmental factors were prevalent: 73% reported rat infestations, 59% experienced high rainfall, and 41% faced flooding. Vary clinical signs potentially associated with leptospirosis were observed in all the farms, including skin diseases (23%), Diarrhoea (21%), weak offspring (17%), stillbirths (13%) and others (less than 7%). Veterinary service access was limited to 23% of farms, and 86% lacked biosecurity measures. This study identified multiple risk factors potentially facilitating leptospirosis transmission in PNG cattle farms, including poor water management, limited disease knowledge, and inadequate veterinary support. However, definitive leptospirosis diagnosis requires laboratory confirmation. These findings provide baseline data for developing targeted intervention strategies.

Keywords: *Leptospirosis, Cattle health, Zoonotic disease, Papua New Guinea, Disease epidemiology, Biosecurity measures, Morobe Province, Environmental risk factors, Veterinary access.*

Introduction

Leptospirosis represents a significant infectious bacterial disease affecting both animals and humans globally (Backer 1998; Evangelista and Coburn 2010; Victoriano et al. 2009; Wójcik-Fatla et al. 2013). The disease demonstrates particularly high prevalence in tropical and subtropical regions, where environmental conditions optimize transmission pathways (Boonsilp et al. 2013; Evangelista and Coburn 2010; Shagfigi et al. 2014). Caused by spiral-shaped bacteria comprising over 200 distinct strains and serovars, leptospirosis affects a broad range of host species, including both animals and humans (Bharti et al. 2003; Brown and Levett 1997; Zelski 2007). The pathogen maintains its presence primarily through mammalian reservoir hosts, particularly rats and dogs, alongside various wildlife species. Transmission occurs through multiple pathways, including inhalation, ingestion, skin abrasions, or direct contact with infected urine or tissues (Victoriano et al. 2009). Environmental transmission frequently occurs through contaminated soil, pasture, and water sources, particularly during periods of high rainfall and flooding increases the transmission risks (Zelski 2007).

In the cattle industry, leptospirosis causes substantial economic losses worldwide (Dhivahar et al. 2019; Hatem et al. 2014). Two serovars in particular - *Leptospira borgpetersenii* serovar Hardjo and *Leptospira interrogans*

*Corresponding Author: **Sinafa Robby**

serovar Pomona - have emerged as primary pathogens, causing systematic illness characterized by abortion, neonatal death, weak calves, high fever, jaundice, decreased milk production, and reddish discoloration of urine (Wynwood et al. 2016; Zelski 2007). While proper sanitation and hygiene practices can effectively prevent leptospirosis transmission, such measures are often challenging to implement in developing countries (Guernier et al. 2018).

Papua New Guinea's tropical climate and agricultural practices create conditions conducive to leptospirosis transmission. Previous studies have documented the presence of leptospirosis in PNG's livestock populations (Javati et al. 2022; Robby et al. 2017; Wai'in 2007; Yombo 2006), yet comprehensive epidemiological data remain limited, particularly regarding risk factors and farmers' knowledge. Understanding the epidemiology of leptospirosis in PNG's cattle industry is crucial for developing effective control strategies. This knowledge gap hampers disease prevention efforts and may contribute to ongoing production losses in the livestock sector (Guernier et al. 2018; Mazzanti et al. 2023).

This cross-sectional survey aimed to assess the prevalence of potential risk factors associated with leptospirosis transmission in cattle farms, evaluate farmers' knowledge and awareness of leptospirosis, document clinical signs potentially associated with leptospirosis, identify management practices that may influence disease transmission risk, and provide baseline epidemiological data to inform future intervention strategies.

Material and Methods

Study design

This research employed a cross-sectional survey methodology, collecting data from multiple farms at three sperate time points through structured questionnaires and semi-structured interviews. The survey instrument captured comprehensive data across multiple parameters: Farm operational details; Farmers' knowledge and understanding of leptospirosis; Clinical and disease aspects in cattle production; Access to veterinary services; Environmental and geographical characteristics; Common clinical symptoms observed in cattle.

Survey location and Population

This cross-sectional survey was conducted in Morobe Province, PNG, from June to August 2023. Morobe Province (6°S latitude) is characterized by distinct seasonal rainfall patterns with annual precipitation ranging from 1000-2500 mm. The province's cattle operations are primarily concentrated in the Markham Valley plains (Wai'in 2007). The study population comprised of 22 cattle farms both commercial and holder population. This study population provides adequate representation of cattle farming operations in Morobe Province for a descriptive cross-sectional study.

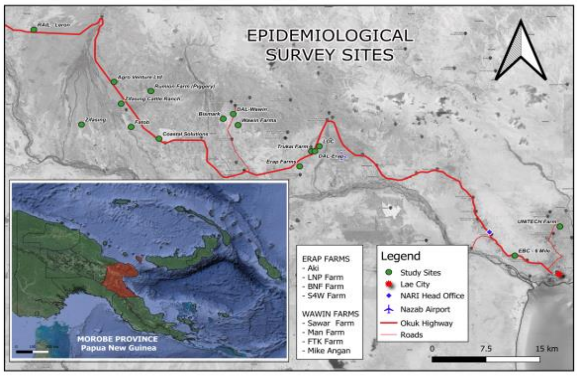

Fig.6 Map of epidemiological survey sites *(QGIS was used for map creation and visualization)*

Data collection

Primary data collection utilized a dual approach combining structured questionnaires and semi-structured interviews. Structured questionnaires were administered by trained interviewers using a standardized format to ensure consistent data collection across all research parameters. Semi-structured interviews allowed for detailed exploration of research objectives, facilitated collection of qualitative insights, and enabled clarification of questionnaire responses. Additionally, researchers conducted systematic physical observations at each farm site, documenting relevant environmental and operational characteristics.

The survey captured both qualitative and quantitative data across several key domains. Farm characteristics data included historical background, geographical location, environmental conditions, and rainfall patterns. Disease status information encompassed farmers' observations of herd health, common clinical symptoms, disease patterns and frequency, and treatment approaches. Risk factors assessment covered potential disease transmission pathways, environmental risk factors, management practices, and biosecurity measures. Herd management data included breed characteristics and sources, vaccination protocols, general farm biosecurity practices, and animal health management strategies.

Data analysis

Information obtained from the current survey using both the structured questionnaire and semi-interviews were processed and analysed using R – program version 12. The data set contains response variables which were mostly binary sets of yes and no, and in some cases, a third variable 'not sure' was added. Since all the data are in categorical form, we used Chi-squared test which is a non-parametric test. Since the data is in matrix format, we rearranged it using melt function into three columns which are farms, variables (target questions) and response (no/yes) respectively. Then we calculated the counts of 'no' and 'yes' (response) for each variable. We divided respective counts of 'no' and 'yes' with the total count and multiplied by 100 to obtain the proportion of each response. Specifically, for different water sources, information sources, clinical signs of diseases and types of treatments, we only use the 'yes' response as it gives the

*Corresponding Author: **Sinafa Robby**

proportion that is comparable to each other. The xtab function was used to create a matrix table of variables versus response (no/yes). Then we analysed the matrix data using the chi-square tests function to get the Chi-squared value (X^2), degrees of freedom (df) and p-value. All the plotting was done with GGPLOT2 package.

Results

Farm characteristics and response rate

Twenty-two cattle farms participated in the survey, representing both commercial and smallholder farms in Morobe Province. The sample included 4 large commercial operations and 18 small commercial farms. No participants declined specific questions, resulting in complete data for all variables.

Table 1. Provides comprehensive details of surveyed farms, including operational scale, breed type, and herd size.

#	Surveyed Farms	Operational Scale	Breed Type	Herd Size
1	LDC	Large holder commercial	Brahman	400
2	RAIL	Large holder commercial	Brahman	More than 1000
3	Trukai Farm	Larger holder commercial	Brahman	400
4	Coastal Solutions	Large holder commercial	Brahman	500
5	Zifasing Cattle Ranch	Small holder commercial	Brahman	400
6	Agro Venture Limited	Small holder commercial	Brahman	More than 50
7	Zifasing	Small holder commercial	Brahman	More than 100
8	Bismark	Small holder commercial	Brahman	614
9	DAL Warwin	Small holder commercial	Brahman	More than 51
10	DAL Erap	Small holder commercial	Brahman	More than 51
11	Rumion Farm	Small holder commercial	Brahman	More than 51
12	EBC	Small holder commercial	Holstein	More than 51
13	Unitech Farm	Small holder Research	Brahman	21-50
14	Mike Angan	Small holder commercial	Brahman	21-50
15	Fatob	Small holder commercial	Brahman	92
16	Aki	Small holder commercial	Brahman	47
17	LNP Farm	Small holder commercial	Brahman	11
18	BNF Farm	Small holder commercial	Brahman	30
19	Sawar Farm	Small holder commercial	Brahman	46
20	Man Farm	Small holder commercial	Brahman	15
21	FTK Farm	Small holder commercial	Brahman	32
22	S 4 W Farm	Small holder commercial	Brahman	77

LDC = Livestock Development Cooperation; RAIL = Ramu Agri Industry Limited; EBC = Evangelical Brotherhood Church: DAL = Department of Agriculture and Livestock. Other acronyms (LNP, BNF, FTK, S4W) are names not defined.

Farmers knowledge, experiences and practices related to leptospirosis in cattle production

Table 2. Chi-squared analysis of farmer responses on leptospirosis, rats, flooding and biosecurity. This table presents chi-squared (X^2) analysis of proportions of responses from 22 farms regarding flooding, rat infestation, leptospirosis information sources, transmission pathways (via rats and flooding), animal disease problems, treatment types, veterinary service access, and biosecurity measures. Each analysis includes X^2 values, degrees of freedom (df), and p-values. The data corresponds to the information depicted in figures 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H and 1I.

Figure	Analysis and Description
1A	Distribution of environmental risk factors across 22 singleton farms shows high rainfall is significantly more common than flooding (X^2 = 54.959, df = 2, $p < 0.001$).
1B	Rat infestation status across farms indicates significantly higher proportion of farms experiencing rat infestations compared to those reporting no infestation or uncertainty (X^2 = 69.835, df = 2, $p < 0.001$).
1C	Assessment of prior leptospirosis knowledge reveals significantly more farms lack knowledge about leptospirosis compared to those with some awareness (X^2 = 40.496, df = 1, $p < 0.001$).
1D	Awareness of rat urine as a leptospirosis transmission vector shows significantly more

*Corresponding Author: **Sinafa Robby**

farms unaware of this transmission route compared to those with knowledge or uncertainty ($X^2 = 41.322$, df = 2, $p < 0.001$).

1E Understanding of rainfall and flooding as leptospirosis transmission factors indicates significantly more farms lack knowledge of these environmental transmission routes compared to those aware or uncertain ($X^2 = 54.959$, df = 2, $p < 0.001$).

1F Perception of animal disease impact on cattle production demonstrates most farmers recognize animal disease as a major production challenge, with few unaware or uncertain ($X^2 = 32.645$, df = 2, $p < 0.001$).

1G Reported cattle mortality rates show significantly more farms experiencing high mortality compared to those reporting low mortality ($X^2 = 42.562$, df = 2, $p < 0.001$).

1H Access to veterinary and animal health services assessment reveals significantly more farms lack access to these services compared to those with access ($X^2 = 29.752$, df = 2, $p < 0.001$).

1I Implementation of biosecurity measures or disease prevention strategies indicates significantly more farms lack these protective measures compared to those with some form of biosecurity protocols ($X^2 = 52.893$, df = 1, $p < 0.001$).

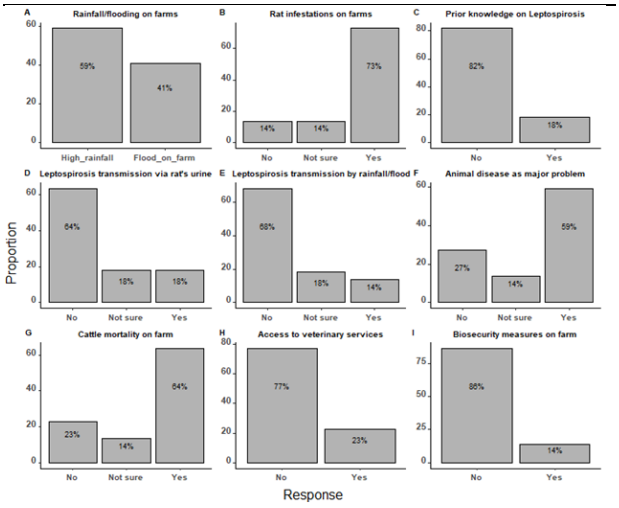

Fig. 1 Cattle farmers' knowledge of leptospirosis: Understanding of clinical manifestations and disease impact on production. Detailed captions and analysis for each bar plot (A-I) are presented in Table 2.

The statistical analysis of this section is outlined in Table 2 and figures in Figure 1 (A-I). Fifty-nine percent (59%) of the farm owners responded that they experienced high rainfall while 41% face flooding on their farms. Most farms experienced rat infestation (73%) while 14% of the farm owners were unsure, however, 14% mentioned no rat infestation. Very few farm owners have prior knowledge of leptospirosis (18%) while the rest had no prior knowledge (82%). Most of the respondents did not know that leptospirosis is transmitted via rat's urine (64%), few are sure of this transmission mode (18%) while 14% are not sure of this transmission. Sixty-eight percent (68%) of the respondents did not know that leptospirosis can be transmitted by rainfall or flooding. However, 14% knew about this transmission mode while 18% were unsure. Most of the farm owners responded that animal disease is a major problem in the cattle industry (59%), however, a few did not see it as a problem (27%) while 14% were unsure. Most of the farms experienced cattle mortality (64%), however, 23% reported no cattle mortality while 14% were not sure. Only 23% of the farms have access to veterinary services while the rest do not have such services. In line with veterinary services, most of the farms do not have biosecurity measures or disease prevention strategies in place (86%) while only a few farms are practicing biosecurity (14%).

Table 3. Chi-squared analysis of farmer responses on water sources, leptospirosis knowledge and cattle health. This table presents chi-squared (X^2) analysis of response proportions from 22 farms regarding water sources, leptospirosis knowledge, cattle mortality, and disease clinical signs. Each analysis includes corresponding X^2 values, degrees of freedom (df), and p-values. The data corresponds to the information depicted in figures 2A, 2B, 2C, and 2D.

Figure	Analysis and Description
2A	Streams and open-source water are common types of water sources for cattle across the 22 singleton farms ($X^2 = 21.52$, df = 3, $p < 0.001$).
2B	While most farm owners learnt about leptospirosis from health officers, they did not learn that in school and media ($X^2 = 67.091$, df = 6, $p < 0.001$).
2C	Most farm owners responded that they observed animals having skin disease and diarrhea while diseases such as lameness and jaundice are rare ($X^2 = 71.38$, df = 10, $p < 0.001$).
2D	Most farm owners isolate their animals when they are sick while vaccination and veterinary drugs are rarely used ($X^2 = 48.168$, df = 5, $p < 0.001$).

The types of water sources used varied across the farms. Most farms use streams and open water sources for their animals (42%) while 29% use water trough (Fig. 2A). Few farms use irrigation (17%) while very few (12%) uses bore water. Generally, farms do not have adequate knowledge of leptospirosis. About 36% of the farm owners came to know about leptospirosis through animal health officers. A fair proportion of farm owners learnt about leptospirosis through awareness, seminar and in schools (18%). Very few respondents learnt about leptospirosis through reading (9%). The type of clinical signs observed varied across the cattle farms (Fig. 2C). Most farm owners indicated that skin disease and diarrhea are common (23%) followed by weak offspring

*Corresponding Author: **Sinafa Robby**

(17%) and still birth (13%). Other clinical signs such as prolapse of uterus, jaundice, lameness, low calving rate, low milk production and others are rare. The types of treatments administered to sick animals also differ across farms (Fig. 2D). Most farms isolate animals when they are sick (42%) followed by drenching and local remedies (15%). Only 13% uses veterinary drugs while 8% uses vaccination and other treatments.

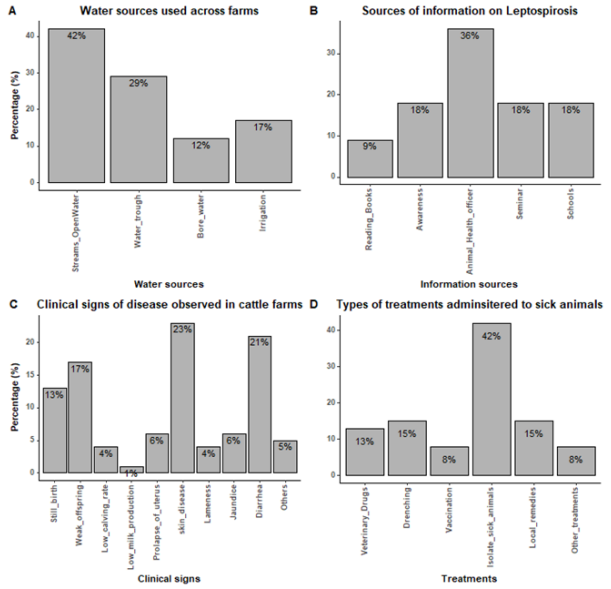

Figure 2. Different water sources (A), information sources (B), clinical signs of diseases (C) and types of treatments used (D) across the 22 farms. The percentages are the count when the farm owners responded 'yes'. Proportions are calculated by dividing individual count of 'yes' by the sum and then multiplied by 100.

Discussion

This cross-sectional survey identified several concerning patterns regarding potential leptospirosis risk factors in Morobe Province cattle farms. The high prevalence of environmental risk factors, combined with limited disease knowledge and inadequate veterinary support, suggests conditions conducive to leptospirosis transmission.

Knowledge gaps and educational needs

The finding that 82% of farmers lack knowledge about leptospirosis represents a critical barrier to disease prevention (Table 2, Fig. 1C). This knowledge deficit is particularly concerning given the high prevalence of environmental risk factors. Similar knowledge gaps have been documented in other developing regions (Mlowe et al. 2023; Fatema et al. 2023; Prabhu et al. 2014; Guernier et al. 2018; Victoriano et al. 2009), highlighting the need for targeted educational interventions. The sources of information used to learn about leptospirosis did not vary across the farms (Table 3; Fig. 2C). There was no difference between commercial and smallholder farms when it comes to information sources on leptospirosis. Among the minority with knowledge about leptospirosis, animal health officers were the primary source of information (36%), followed equally by awareness campaigns (18%), seminars (18%), and schools (18%), while book reading was the least common source (9%) (Fig. 2B).

The limited awareness extends to critical transmission pathways. Most farmers (64%) were unaware that rodents serve as vectors for leptospirosis, which is particularly troubling given the high reported rat infestation rates and research showing *Leptospira* spp. can remain viable for up to 200 days under favourable conditions (Pastre et al. 2020). Similarly, 68% of the respondents did not recognize rainfall and flooding as transmission vectors, despite numerous studies documenting this relationship (Evangelista and Coburn 2010; Guernier et al. 2018; Zelski 2007) and the region's documented rainfall patterns.

Commercial farms with access to private veterinary services generally demonstrated better awareness, highlighting a disparity in access to disease information. These knowledge gaps could have drastic effects on cattle production and underscore the urgent need for improved education on leptospirosis epidemiology to enable farmers to implement effective prevention strategies against this bacterial zoonosis and other livestock diseases.

Environmental risk factors

The predominant reliance on open water sources (42% of farms – Fig. 2A) combined with high rainfall patterns creates conditions favorable for leptospirosis transmission. The presence of rat infestations in 73% (Fig. 1B) of farms further compounds transmission risks, as rodents serve as important reservoir hosts for *Leptospira* species.

The high prevalence of these risk factors aligns with previous studies documenting leptospirosis transmission through contaminated water sources (Evangelista and Coburn 2010; Guernier et al. 2018). The situation is further complicated by the region's substantial rainfall patterns, with survey data confirming frequent heavy rainfall events significantly exceeding flooding occurrences. While some commercial operations (e.g., RAIL and Rumion) can implement water management strategies through mechanical intervention, most smallholder farms lack such capabilities, forcing reliance on basic mitigation strategies such as livestock relocation. Farms situated along the big Markham River indicated experiences of their cattle being drowned during heavy rainfall and flooding.

The cross-sectional epidemiological survey also reveals the risk of leptospirosis transmission through contaminated water from infected rat urine or infected cattle defecating or urinating directly into the water sources. This creates a risk of leptospirosis transmission between farms during heavy rainfall and flood (CFSPH 2005). However, this survey was not able to establish the history of leptospirosis transmission between or within cattle farms during rainfall season and floods.

Clinical impact and healthcare access

The survey findings reveal substantial clinical impacts across surveyed cattle operations in PNG. Production losses include high mortality rates along with diverse clinical manifestations

*Corresponding Author: **Sinafa Robby**

such as skin disease, stillbirths, and weak offspring. Smallholder farms experience more stillbirth and weak offspring than in commercial farms (Table 3, Fig. 2C). While clinical signs potentially consistent with leptospirosis were observed in cattle farms, it is crucial to emphasize that these observations do not constitute confirmed leptospirosis diagnosis. The clinical signs reported (stillbirths, weak offspring, skin diseases) are nonspecific and could result from various other pathogens including brucellosis, neosporosis, bovine viral diarrhea, or other cattle diseases. Laboratory confirmation through serological testing or bacterial isolation is essential to establish definitive leptospirosis diagnosis. This survey provides only circumstantial evidence of potential disease presence based on compatible clinical presentations and environmental risk factors.

Previous research has established leptospirosis as a primary concern causing abortion and mortality in cattle production (Dhivahar et al. 2019; Hashimoto et al. 2017; Wai'in et al. 2006). The heightened risk of disease transmission necessitates proper awareness, training on prevention strategies, and veterinary support. A significant challenge to animal health services in PNG stems from insufficient veterinarians and animal health officers available to address farmers' needs.

The types of treatments administered to sick animals varied across farm (Table 3; Fig. 2D). Most smallholder farms resort to restraining and isolating sick animals, followed by applying local remedies and drenching. Access to proper veterinary medicine is not common practice in smallholder farms, with sick animals often left to recover without intervention.

A significant healthcare access disparity exists, with 73% of the farms lacking access to veterinary services (Table 2, Fig. 1H). Only large commercial operations such as Trukai Farms, Rumion Farm, and Ramu Agri Industries Limited can afford private veterinarians, veterinary drugs, and routine vaccination programs against common cattle diseases.

This situation highlights the urgent need for government agencies and authorities to investigate and address the requirement for improved animal health services, increase awareness, and provide appropriate animal health training throughout the country.

Biosecurity and disease prevention

The survey revealed critical deficiencies in biosecurity measures across cattle operations. Most cattle farms (83%) especially smallholder farms lack formal biosecurity protocols or disease prevention strategies, while only a few (14%) commercial farms have implemented some form of protection against potential disease incursion and transmission (Table 2, Fig. 1I). The cross-sectional survey identified Ramu Agri Industry Limited and Rumion Farms to implement partial biosecurity measures, focusing primarily on breeding stock screening, vaccination programs, and movement control implementation.

The lack of comprehensive biosecurity measures, particularly among smallholder operations, represents a significant vulnerability in regional disease control efforts. This finding aligns with documented challenges in implementing biosecurity measures in developing regions (Heckert et al. 2011; Msimang et al. 2021).

Implementation gaps stem from limited understanding of disease prevention strategies and insufficient resources. Other notable significant risk factors include frequent integration of cattle with other livestock species, close human-animal contact patterns, and limited disease screening in breeding stock. This integration of different animal species with cattle substantially increases the risk of disease transmission between various species.

Conclusions

This cross-sectional survey identified multiple risk factors potentially associated with leptospirosis transmission in PNG cattle farms, including poor water management, limited disease knowledge, and inadequate veterinary support. However, the absence of laboratory confirmation means that actual leptospirosis occurrence remains unverified, and all inferences about disease presence are hypothetical.

The study provides baseline epidemiological data that can inform future research priorities and intervention strategies. Key findings include widespread knowledge gaps (82% of farmers), high prevalence of environmental risk factors (73% rat infestation, 42% use open water source), and limited healthcare access (77% without veterinary services). This limitation, coupled with inadequate biosecurity measures affecting 86% of surveyed farms, presents substantial challenges for disease control and prevention.

These findings contribute to understanding potential disease risks in PNG's cattle industry while acknowledging the need for confirmatory diagnostic studies to establish definitive disease presence and transmission patterns.

List of abbreviations

CVO	Chief Veterinary Officer
DAL	Department of Agriculture and Livestock
df	degrees of freedom
EBC	Evangelical Brotherhood Church
LDC	Livestock Development Cooperation
NAQIA	National Agriculture Quarantine and Inspection Authority
p	p-value
PNG	Papua New Guinea
PNG UOT	PNG University of Technology
PNG UNRE	PNG University of Natural Resources and Environment
QGIS	Quantum Geographic Information System
RAIL	Ramu Agri Industry Limited
RVO	Regional Veterinary Officer
X^2	Chi-square test

Declarations

Acknowledgements

The authors gratefully acknowledge PNG UOT and PNG UNRE for their financial support and research assistance. We extend our sincere thanks to NAQIA for facilitating this study.

*Corresponding Author: **Sinafa Robby**

Our appreciation also goes to the participating cattle farms in Morobe Province for providing information vital to this research. Special thanks to Mr. Wilson Kumne from the PNG National Research Institute for constructing and visualizing the survey site map using QGIS software.

Funding
Funding support for this work was received from the PNG University of Technology (PNGUOT) and PNG University of Natural Resources and Environment (PNGUNRE).

Authors contributions
SR, as the first author, made substantial contributions to the research design, implementation, and overall manuscript preparation.

KI performed the data sorting, analysis, and interpretation.
ST assisted in designing the epidemiological survey and provided comprehensive editing.

MM supervised the study design and critically revised the manuscript.

Competing interests
The authors declare that they have no competing interest.

Ethics approval
Ethical approval and clearance were obtained from the National Agriculture Quarantine and Inspection Authority (NAQIA) through both the Chief Veterinary Officer (CVO) and Regional Veterinary Officer (RVO), securing access to cattle farms and permission for sample collection. NAQIA serves as PNG's mandated authority for animal health and disease oversight. Additionally, the research protocol received approval from the PNG University of Technology Research Ethics Committee.

Consent to participate
Not applicable

Consent to publish
All authors of this article have agreed to publish in the Discover Animals

Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Clinical trial number
Not applicable

References

1. Backer, D G. 1998. "Natural Pathogens of Laboratory Mice, Rats, and Rabbits and Their Effects on Research." *Clinical Microbial Reviews* 11 (2): 231 -266. https://doi.org/10.1128/CMR.11.2.231
2. Bharti, AR. , JE. Nally, JN. Ricaldi, MA. Matthias, MM. Diaz, MA. Lovett, PN. Levett, RH. Gilman, MR. Willig, and E. Gotuzzo. 2003. "Leptospirosis: a zoonotic disease of global importance." *The Lancet Infectious Diseases* 3 (12): 757-771. https://doi.org/doi: 10.1016/s1473-3099(03)00830-2
3. Boonsilp, S., J. Thaipadungpanit, P. Amornchai, W. Vanaporn, MS. Bailey, MTG. Holden, C. Zhang, X. Jiang, N. Koizumi, and K A. Taylor. 2013. "Single Multilocus Sequence Typing (MLST) Scheme for Seven Pathogenic *Leptospira* Species." *Plos One* 7 (1); 1954. https://doi.org/10.1371/journal.pntd.0001954
4. Brown, P D. , and P N. Levett. 1997. "Differentiation of *Leptospira* species and serovars by PCR-restriction endonuclease analysis, arbitrarily primed PCR and low-stringency PCR." *Journal of Medical Microbiolology* 46 (2): 173-181. https://doi.org/10.1099/00222615-46-2-173
5. CFSPH. 2005. "Leptospirosis. In: Centre for Food Security and Public Health." *Institute of International Coperation in Animal Biologics*. www.cfsph.iastate.edu › Factsheets › leptospirosis-es. Accessed 21 June 2024
6. Dhivahar, M., R. Ambily, S. Joseph, V.H. Shyma, P.S. Reshma, and M. Mini. 2019. "Seroprevalence of Leptospirosis among Aborted Goats in Kerala." *International Journal of Current Microbiology and Applied Sciences* 8 (8): 1403-1407. https://doi.org/10.20546/ijcmas.2019.808.163
7. Evangelista, V K., and J. Coburn. 2010. "*Leptospira* as an emerging pathogen: a review of its biology, pathogenesis and host immune responses." *Future Microbial Journal* 5 (9): 1413-1425. https://doi.org/10.2217/fmb.10.102
8. Fatema, Ambreen., Manjunatha. Ramu, Kannan. Thiruvengadam, Pulikkottil Lttoop. Sunish, and Paluru. Vijayachari. 2023. "Knowledge, attitude, and preventive practices of leptospirosis affected populations in South Andaman, India: A cross-sectional study." *Journal of Health Sciences* 13 (2): 105-112. https://doi.org/https://doi.org/10.17532/jhsci.2023.2145
9. Guernier, Vavina., Cyrille. Gorant, Jackie. Benscop, and L Collin. Lau. 2018. "A systematic review of human and animal leptospirosis in the Pacific Islands reveals pathogen and reserviour diversity." *Plos One Neglected Tropical Disease* 14 (12): 6503. https://doi.org/doi: 10.1371/journal.pntd.0006503
10. Hashimoto, Yumi Vanessa., Torres Roberta. Chideroli, Juliane. Ribeiro, Alcindo Amauri. Alfieri, da Geraldo Marcio. Costa, de PaduaUlisses. Pereira, and Cesar deJulio. Freitas. 2017. "Serological and molecular findings in diagnosis of leptospirosis serovar hardjo in a dairy bovine herd." *Semina: Ciências Agrárias, Londrina*, 38 (5): 3155-3164. https://doi.org/10.5433/1679-0359.2017v38n5p3155
11. Hatem, M Essam., S Nagwa. Ata, M Amr. Abdou, S Eman. Ibrahim, M A. Bakry, and A. Samir. 2014. "Surveillance of Bovine Leptospirosis: Isolation and

*Corresponding Author: **Sinafa Robby**

Serodiagnosis." *Global Veterinaria* 13 (1): 127-132. doi: 10.5829/idosi.gv.2014.13.01.84271

12. Heckert, A Robert., J Craig. Reed, K Felix. Gmuender, Maureen. Ellis, and Willy. Tonui. 2011. "International Biosafety and Biosecurity Challenges: Suggestions for Developing Sustainable Capacity in Low-resource Countries." *Applied Biosafety* 16 (4): 223-230. doi.10.1177/153567601101600404
13. Javati, Serah., Vanina. Guernier, Marinjho. Junduo, Sinafa. Robby, Job. Kimopa, Tobias. Maure, Emma. Mcbryde, William. Pomat, Mohammed Yazid. Abdad, and F Paul. Horwood. 2022. "Diversity of *Leptospira* spp. in bats and rodents from Papua New Guinea." *Transboundary and Emerging Disease* 69 (6): 4048-4054. https://doi.org/doi: 10.1111/tbed.14725
14. Mazzanti, Mariana. , Exequiel. Scialfa, Mariana. Rivero, and Juan. Passucci. 2023. "Epidemiology of *Leptospira* spp. infection in a beef cattle area of Argentina." *Frontiers in Veterinary Science*. https://doi.org/doi: 10.3389/fvets.2023.1083024
15. Mlowe, Gerald., Kambere Olivier. Kavulikirwa, Issac. Makundi, Abdul. Katakweba, and Shadrack Robert. Machangu'u. 2023. "Assessment of the Knowledge and Awareness of Leptospirosis among Households, Farmers, and Livestock Keepers in Unguja Island, Tanzania: A Cross-Sectional Study." *Tropical Medicine and Infectious Disease* 8: 15. https://doi.org/10.20944/preprints202304.0152.v1
16. Msimang, Veerle., K Melinda. Rostal, Claudia. Cordel, Catherine. Machalaba, Stefano. Tempia, Bagge. Whitney, J Felicity. Burt, B William. Karesh, T Janusz. Paweska, and N Peter. Thompson. 2021. "Factors affecting the use of biosecurity measures for theprotection of ruminant livestock and farm workers againstinfectious diseases in central South Africa." *Transboundary and Emerging Diseases* 69 (5): 1899 -1912. https://doi.org/10.1111/tbed.14525
17. Pastre, Giovani Batista., Isabela Carvalho dos. Santos, Robson Michael. Delai, Edinalva Madalena de Almeida. Mota, Lidiane Nunes. Barbosa, Roberta Torres. Chideroli, Lucienne Garcia. Pretto-Giordano, Luiz Rômulo. Alberton, Ulisses de Pádua. Pereira, and Daniela Dib. Gonçalves. 2020. "Molecular Identification of *Leptospira* interorgan in Naturally Infected Cows from a Rural Property in the Border Region." *Semina: Ciências Agrárias, Londrina*, 41 (4): 1433-1438. https://doi.org/10.5433/1679-0359.2020v41n4p1433
18. Prabhu, N. , J. Meera, G. Bharanidharan, K. Natarajaseenivasan, M. Ismail, and A. Uma. 2014. "Knowledge, Attitude and Practice towards Leptospirosis among municipal workers in Tiruchirapalli, India." *International Journal of Pharma Research and Health Sciences* 2 (3): 246-254. https://www.pharmahealthsciences.net/pdfs/urgent/9_MS_1463.pdf
19. Robby, Sinafa., Maure. Tobias, Johnson. Makaen, Job. Kimopa, and Mohamed Yazid. Abdad. 2017. "Prevalence of *Leptospira* spp. in rats from Eastern Highlands Province, Papua New Guinea:." *PNG Medical Journal* 60 ((3-4)): 116-121. https://www.pngimr.org.pg/wp-content/uploads/2019/10/PNGMedJ-2017-Vol60-Sep-Dec.pdf
20. Shagfigi, T., Salehi T. Zahreai, G. Abdollahpour, L. Asadpour, H. Akbarein, and A. Salehzadeh. 2014. "Molecular Detection of *Leptospira* spp. In the urine of Cattle in notheran Iran." *Irania Jornal of Veterinary Research* 15 (4): 402-405. https://pubmed.ncbi.nlm.nih.gov/27175139/
21. Victoriano, B Ann Florence. , D Smythe. Lee, Gloriani-Barzaga. Nina, L Cavinta. Lolita, Kasai. Takeshi, Limpakarnjanarat. Khanchit, Lee Ong. Bee, Gongal. Gyanendra, Hall. Julie, Anne Coulombe. Caroline, Yanagihara. Yasutake, Yoshida Shin-Ichi, and Adler. Ben. 2009. "Leptospirosis in the Asia Pacific region." *Biomedical Central Infectious Diseases* 4 (9). https://doi.org/10.1186/1471-2334-9-147
22. Wai'in, Peter. 2007. " Epidemiology of Infection with *Leptospira* Species in Livestock in Papua New Guinea" Unpublished Thesis Submitted for Doctors of Philosophy, Murdoc University. https://researchportal.murdoch.edu.au/esploro/outputs/doctoral/Epidemiology-of-infection-with-leptospira-species/991005540603707891#file-0
23. Wai'in, Peter., I. Robertson, S. Fenwick, and L. Smythe. 2006. "Seroprevalence of Leptospirosis in Cattle in Papua New Guinea." 11th International Symposium on Veterinary Epidemiology and Economics - New Zealand. https://sciquest.org.nz/search/results-2/downloadfulltext/64157
24. Wójcik-Fatla, A., V. Zając, J. Sroka, M. Piskorsk, E. Cisak, A. Sawczyn, and J. Dutkiewicz. 2013. "A small scale survey of *Leptospira* in mammals from eastern Poland." *Annals of Agricultural and Environmental Medicine* 20 (4): 705-707. https://www.aaem.pl/pdf-72001-9228?filename=9228.pdf
25. Wynwood, SJ., MA. Burns, GC. Graham, SL. Weier, DB Makay, and SB. Craig. 2016. "Serological diagnosis of leptospirosis on bovine serum samples using a microsphere immunoassay." *Vet Rec Open* 3 (1). https://doi.org/doi: 10.1136/vetreco-2015-000148corr1
26. Yombo, Keponge Andy. 2006. "The Sero - Epidemiology of Leptospirosis in Ruminants Farm Animals in PNG." Post Graduate Diploma in Agriculture Thesis., Agriculture Department, Papua New Guinea University of Technology.

*Corresponding Author: **Sinafa Robby**

27. Zelski, Richard. 2007. *Leptospirosis in cattle herds.* New South Wales Department of Primary Industries Australia. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0014/110084/leptospirosis-in-cattle-herds.pdf

*Corresponding Author: **Sinafa Robby**